FACTSHEET

AGRICULTURAL ENGINEERING

ORDER NO. 06-011

JANUARY 2006

AGDEX 717

Ontario Ministry of Agriculture, Food and Rural Affairs

ENERGY EFFICIENT SWINE LIGHTING

S. Clarke, P. Eng. and R. Chambers, P. Eng.

LIGHTING BASICS

Lighting plays a large role in livestock and poultry production performance. It is possible to reduce energy costs by making small changes to the lighting on your swine operation. A well designed, energy efficient lighting system can mean higher lighting levels, better bird performance and lower energy costs.

This Factsheet offers suggestions on how to change your lighting system to reduce energy costs by 15%–75%. It highlights different lighting systems such as incandescent, fluorescent, compact fluorescent, fluorescent tube lighting, high intensity discharge and Light Emitting Diode (LED). An example of the cost to change from an incandescent to a fluorescent light system is also included.

LIGHT LEVELS

To know how to reduce energy costs it is important to understand the terms used to measure light.

- **Lumens** – light output from a lamp is measured in the term "lumens" (lm). For example, a 40 watt (W) incandescent light bulb produces about 13 lumens per watt or 13 lm/W.
- **Lux or Foot-Candle** – the light level at the working surface is measured in lux or foot-candle (fc). [10 lux equals ≈1 fc] Typical light levels in animal pens and corner areas of barns can be less than 5 lux or ½ fc. Outside on a bright sunny day in mid summer the light level will be around 80,000 lux or 8,000 fc.
- **Average Rated Life** – the average time it takes for 50% of light bulbs to fail.
- **Colour Rendering Indexes** (CRI) – the measurement of the light sources ability to render colours the same way sunlight does.

When considering ways to reduce energy costs think about how to get the most light output per lamp size (lm/W). Typical lumen outputs are shown in Table 1 and *Figure 1* along with other light system information.

TABLE 1. General Characteristics of Light Sources Used for Indoor Lighting of Livestock and Poultry Facilities

Lamp Type	Lamp Size (W)	CRI	Efficiency (Ballast losses not included) (Lumens/ W)	Typical Lamp Life (hr)
Incandescent	25–200	100	11-20 (Ave 16.5)	750-5,000
Long Life	25–200	100	Ave 12.4–20	Long life up to 5,000 hr
Halogen	50–150	100	18-25	2,000-3000
Fluorescent T8 (4 ft)	32	75	88	20,000 (24,000 for low mercury premium lamps)
Fluorescent T5 (4 ft)	28	85	104	20,000
Fluorescent T5HO (4 ft)	54	85	93	20,000
Compact Fluorescent	5–57	80–90	50-80	10,000
Metal Halide	35–70 400	60–80	60-94	7500-10,000 20,000 (higher wattages, longer life)
High Pressure Sodium	35–400	20–80	63-125	15,000-24,000
Light Emitting Diode	1.2–1.4	70–90	16-53	60,000-100,000 White is lower

Note: CRI means colour-rendering index. Fluorescent T12 (1.2 m or 4 ft) has not been included, as they are not recommended. This is because: 1) they are not as energy efficient as T8 or T5; and 2) complete fixtures and replacement components will be unavailable over the next few years

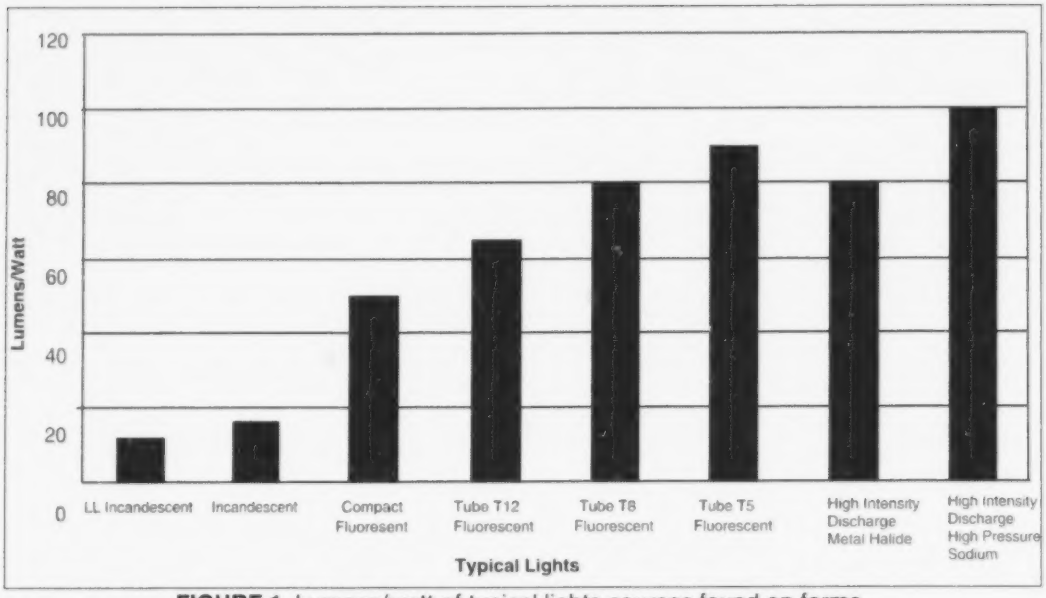

FIGURE 1. Lumens/watt of typical lights sources found on farms.

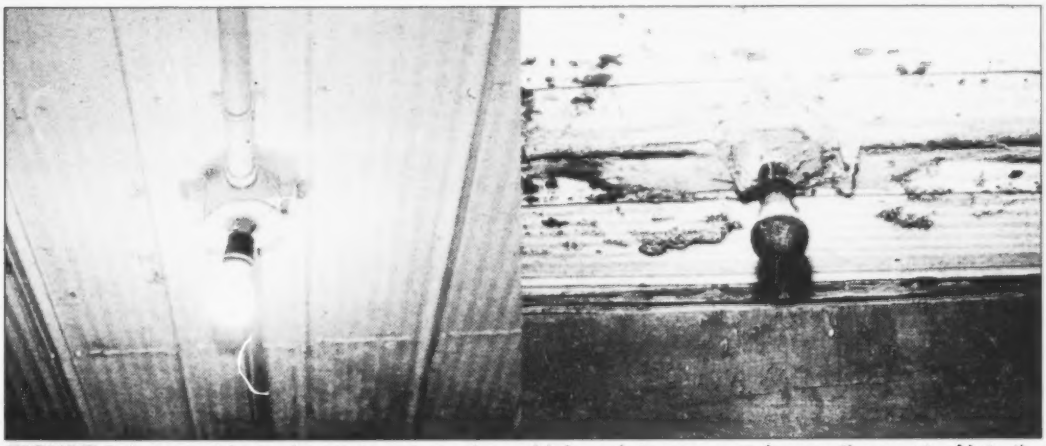

FIGURE 2. Low cost incandescent systems have high maintenance and operating costs. Note the dirty build-up on a long-life lamp.

LIGHT TYPES

Incandescent

With today's relatively high light-level requirements in barns and with lights on for longer periods, the old Edison style incandescent lamps are only about 5% efficient at converting energy to light. The rest is wasted as heat energy. Incandescent lights also attract flies and other insects, and are quickly coated with dirt that further reduces the amount of light available. *Figure 2* shows examples of incandescent lights and the dirt problem. Incandescent lights also have a relatively short-rated life compared to other lighting types (see Table 1). For example, a 100 W, 1,000 hr (standard rated lamp) could be expected to last 63 days at 16 hr/day. Installing 'long life' lamps with a rated life of 5,000 hr, the bulb would last 312 days, but the actual light output is reduced by about 25% over the regular 1,000-hr lamp.

Fluorescent

Fluorescent light should be the main light source in new or renovated poultry production. Fluorescent light is very energy efficient compared to incandescent, has long life cycles (when correct fixtures are installed and adequate maintenance) and can provide good light quality for swine.

A few reasons to switch to fluorescent lighting from incandescent are listed here.

- Fluorescent lighting takes less energy to provide the desired level of light.
- Fluorescent tube lamps last 20,000 hr and cost about $2.00 each; incandescent lamps cost as little as $0.50/each and last from 1,000 (regular life) to 5,000 (long life) hours (anything over 2,000 hr is considered long life).
- Conversion from incandescent to fluorescent will reduce energy usage by up to 75%.
- Fluorescent typically has a payback time of less than 2 years. In some cases payback can be as soon as 4 months.

TYPES OF FLORESCENT SYSTEMS

There are 2 types of fluorescent systems used on farms: **compact** and **tube fluorescents.**

Compact Fluorescent

Compact fluorescent (CF) lighting systems provide good energy efficiency and can easily replace incandescent fixtures. There are 2 main types: *electronic ballast* and *electromagnetic.* (See *Figure 3* and *4.*)

- Electronic ballast systems have a rated life of 10,000 hr.
- Electromagnetic units have a detachable lamp from the ballast. Lamps are rated at a life of 10,000 hr, ballasts at 40,000 hr. Generally, compacts are a good, low cost retrofit.
- Compact fluorescent bulbs for barns need to be rated or approved for damp locations.
- Purchase compact fluorescent bulbs rated "Energy Star" for the best quality and light output.
- For better power quality, look for products with low (below 30%) total harmonic distortion (TDH) and power factors greater than 0.9.

To see which size CF to install, determine the lumen output of the current incandescent lights and then match this value with the CF lumen output. See Table 2.

TABLE 2. Light Output of Compact Fluorescent compared to Incandescent Bulbs (in Lumens)

Incandescent Light Bulbs		Compact Fluorescent Light Bulbs	
Watts	Lumens	Watts	Lumens
25	270	5	250
40	510	7	400
52	780	9	600
60	860	15	900
90	1,540	18	1,250
100	1,680	26	1,800

Source: hydroonenetworks.com/en/efficiency/downloads/PowerSaver_02_Lighting.pdf

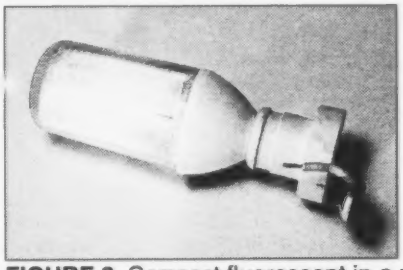

FIGURE 3. Compact fluorescent in a moisture resistant fixture. (Source: Agviro, Inc.)

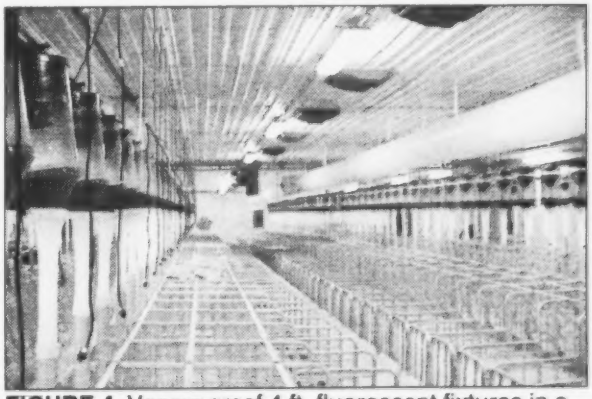

FIGURE 4. Vapour proof 4 ft. fluorescent fixtures in a swine gestation unit.

To date there has only been limited success with dimming compact fluorescents, however future research will likely solve the reliability issue. Only CF systems labelled "dimmable" can be used when dimming. CF lights are a very good choice in swine barns when low levels of light are required. However, if dimming is required, a mix of incandescent with CFs may be a good solution. (See *Figure 3*)

When considering retrofitting a lighting system bear in mind that CF lamps have shorter equipment life and higher replacement costs compared to T8 (standard 4 ft) fluorescent tube systems. See the section below on fluorescent tube lighting for details.

Fluorescent Tube Lighting

Fluorescent tubes come in a variety of lengths and diameters. Typically farms use 4-foot lengths (1.2m). Tube diameter is measured in eighths of an inch. T12s (1.5 in.) — the old standard— are being replaced by T8 (1 in.) and T5 (0.6 in.) systems (see *Figure 5*). (These are the standard industry sizes.)

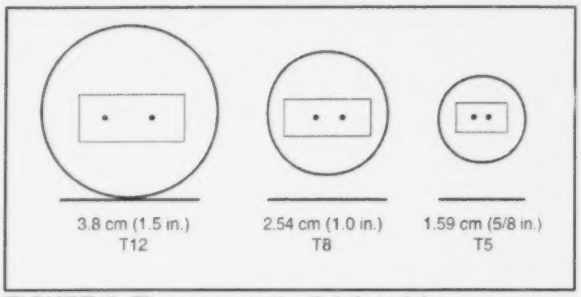

FIGURE 5. Fluorescent tube lighting sizing.

For barns where the ceiling height is less than 3.7 m (12 ft) the new recommendation is the T8 fluorescent fixture with electromagnetic ballast, mounted in weatherproof fibreglass or plastic housing with a continuous gasket between the lens and fixture. Also it is important to ensure the fixture uses 8 clips to hold the lens on so there is less chance of barn air getting into the fixture. These units are typically:

- 4 times more efficient than regular incandescent lights
- up to 30% more efficient than T12 fluorescent tubes
- last at least 20 times longer than regular life incandescent lamps.

T8 fluorescents are an ideal energy efficient alternative to incandescent, compact fluorescent and T12 fluorescent systems. T5 fluorescent tube systems are shorter than T12 or T8. They produce more light, have better colour rendition (more true light), a higher efficiency and more dimming options available. They maintain their light level better than T12 and most T8 systems. They provide 95% of their original light output after 40% (8,000 hr) of their average life. T5 lamps are not recommended for use in vapour-tight fixtures due to heat build up; therefore, their use on farms will be limited to clean, dry environments. However future research will likely solve the over heating and reliability issue of T5.

Dimmable fluorescent tube lights are currently being tested in several commercial turkey grower facilities in Ontario. The advantage of a dimming system is the ability to simulate dawn and dusk periods by slowly raising and/or lowering light levels.

Photocells controllers can be used with fluorescent lights in barns with windows and curtains. The photocell controller can dim or turn off lights near sidewalls during the day when natural light levels are sufficient. This process is called Day Lighting and can save even more energy and money

HIGH INTENSITY DISCHARGE (HID)

Where barn ceilings are more than 3.7 m-high (12 ft-high), for example, poultry barns and machinery sheds. consider more efficient high intensity discharge (HID) fixtures, including metal halide (MH) and high pressure sodium (HPS). They are easy to install and maintain and require fewer fixtures to provide the same level of light. (See *Figure 6* and *7*.)

FIGURE 6. High pressure sodium fixture. (Source: Agrvio)

Metal halide fixtures can be operated on either a regular or pulse start ballast. A pulse start ballast will save about 12.5% or 50 W on a 400 W metal halide fixture.

A study conducted in an Ontario commercial broiler facility comparing a dimmable HPS system to incandescent lights showed that the HPS system resulted in better bird performance, used less electricity and fewer costs, yielding improved profit per kilogram. Another key part of this study showed that the controller is a critical component and needs to be a good quality unit or dimming will not work well.

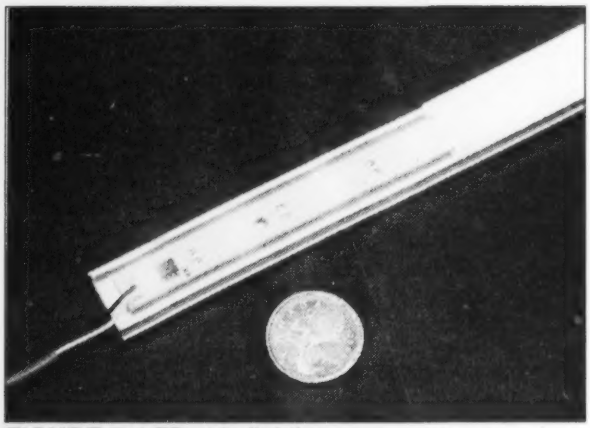

FIGURE 7. LED strip lighting. (Source: GVA Lighting Inc.).

LIGHT EMITTING DIODE (LED)

Light Emitting Diode or LED systems are not yet used in livestock and poultry production facilities yet. Research is required to ensure this technology will fit with agricultural applications. Energy efficiency of LED lamps can be very high (50 lumens/W) and life is much longer (up to 100,000 hr) than other light systems. If the technology can be adapted for barn environments, it is expected that LED lighting systems will provide large on-farm energy savings in the future.

LEDs come in various forms — spot, linear or strip and monochromatic colours. They can be dimmed.

The advantages of LEDs include:

- environmental friendly–energy efficient with 1/5th of the power consumption of incandescent lamps. LEDs contain no mercury and since they last longer there is less waste
- long life - LEDs lasts up to 100,000 hr compared to the typical incandescent bulbs at 1,000 hr or 20,000 hr fluorescent lamps
- low maintenance cost
- miniaturization - small size allows them to be used in areas not easily accessible
- high reliability - LEDs are solid-state devices, without moving parts, glass or filament to break. They are robust and vibration proof
- directed light for increased system efficiency
- fully dimmable
- multicolour - available in all colours
- high speed response - immediate response, no preheat or starting time required.

TIMING AND MOTION SENSORS

Other considerations for energy efficient lighting systems include the use of timers, programmed to turn lights on/off to meet daily livestock needs and motion sensors in personnel areas such as hallways and entranceways.

Recent innovations include:

- A controller that will gradually turn light intensity up and down to simulate the sun. These controllers allow an operator to do this many times in a day.

- A controller that uses a photocell to change the light intensity as required from each row of lights. This is useful where a barn has translucent sidewall openings and can thus use the natural light as required and save substantial energy.

SWINE

Lighting plays a significant role in reproductive and overall swine production performance. The cost of electricity for lighting is a small percentage of the cost of production for swine; however, it is possible to reduce energy costs, increase lighting levels and improve performance with a well-designed, energy efficient lighting system. A good lighting system should provide proper light levels economically with low maintenance costs.

Incandescent lighting is very common in swine barns. A 100W-1,000 hr standard rated incandescent bulb should last 63 days in the breeding barn. Long life incandescent bulbs at 5,000 hr rated life only last 312 days and the actual light output is reduced by about 25% over the regular 1,000 hr bulb.

Compact fluorescent (CF) lamp and ballast systems provide good energy efficiency and are easily retrofitted into incandescent fixtures. However, the shorter equipment life and higher lamp and ballast replacement costs compared to T8 fluorescent tube systems increases operating costs and reduces cash flow.

Barns with a ceiling height of less than 3.6 m should install T8 fluorescent lamps with matching electronic ballast, mounted in a weatherproof fibreglass or plastic housing with gasketted diffuser. These units are more than 4 times as efficient and the lamps last at least 20 times as long as a regular life incandescent lamp. See Table 1 for relative system efficiencies and lamp life comparisons.

- Where barn ceiling height exceeds 3.6 m, consider the more efficient high intensity discharge (HID) fixtures. They are easier to install, maintain and require fewer fixtures to provide the same level of light. Types to be considered include:

- Metal halide (white light, good colour rendition, good to excellent life)
- High-pressure sodium (can be colour corrected for good colour rendition, excellent life, low cost).

SYSTEM COSTS FOR RETROFIT AND NEW INSTALLATIONS

The cost to install and run an incandescent light system in a 200 head grow/finish room, with dimensions 40 ft x 40 ft x 10 ft, 8 pens and a centre alleyway, was compared with the cost of a fluorescent tube system in a similar facility. The cost comparison was based on energy costs of $0.0953/kWh (March 2005 rate) and with lights typically running 7 hours per day on average.

The incandescent lighting system consisted of 1, 150W, regular life incandescent lamp per pen in the centre. This would provide just over 3 fc (32 lux). This system would cost about $120 to install and $296 annually to operate.

Installing four, 4 ft double tube, waterproof T8 fluorescent fixtures, with one fixture per pair of pens, would provide an increased light level of 5 fc (a 66% increase). This T8 system would cost $500 to install and only $73 per year to operate.

For a retrofit, with all the capital costs paid with savings, the simple payback is 2.2 years. For a new facility, where the original cost for incandescent is deducted from the total fluorescent capital cost, the payback is even faster at 1.6 years.

RECOMMENDED LIGHT INTENSITIES AND PHOTOPERIODS FOR SWINE

Each type of production requires different light levels and photoperiods. See Table 3, *Recommended Light Levels and Photoperiods for Swine Housing.* The Recommended Code of Practice for the Care and Handling of Farm Animals – Pigs (Publication 1898/E, Agriculture and Agri-Food Canada) recommends at least 8 hours of light per day, at a level adequate to observe pigs. Five fc (50 lux) are adequate and will be at least twice as much light as typically is found in many older swine barns. Design is critical to maximize light efficiency and minimize over lit or under lit areas.

Breeding/gestation barns require lighting photoperiods from 14–16 hours per day, to bring on more quickly and extend breeding sow estrus. Nursery pigs, particularly those in Segregated Early Weaning (SEW) need 24 hr of light at low levels and higher levels for day time feeding, inspection, etc. Farrowing rooms also need 24 hr of light per day, particularly where heat lamps are not used. Again, it can be low level during the night.

TABLE 3. Recommended Light Levels and Photoperiods for Swine Housing

Type of Housing	Light Levels (fc) lux	Photo-period (h/d)	Comments
Breeding/Gilts	>10	14-16	Necessary for estrus cycling
Gestation	>5	14-16	To assist missed cycles, bring estrus on again
Farrowing	5–10	8	If no heat lamps, some light in room 24 h/d
Nursery	5	8	Some light in room 24 h/d
Grower-Finisher	5	8	Minimum 6 h/d unbroken light recommended

SUMMARY

Over the long run, lighting on poultry farms has the potential to save energy for the farmer. One simple way to reduce energy costs by 75% is to switch from incandescent lighting to fluorescent T8 lighting. Using dimmers can also reduce energy costs. By making these changes, along with other improvements, your poultry operation lighting system will be more energy efficient. This can lead to improved farm productivity and increased revenue, while lowering energy costs.

This Factsheet was written by **Steve Clarke**, P.Eng., Energy and Crop Systems Engineer, and **Robert Chambers**, Swine and Sheep Housing and Equipment, P. Eng., Environmental Policy and Programs Branch, OMAFRA. It was peer reviewed **Elin Gwyn**, Marketing and Communications Officer, Environmental Policy and Programs Branch, OMAFRA.

FOR YOUR NOTES

Agricultural Information Contact Centre
1-877-424-1300
ag.info@omafra.gov.on.ca

www.omafra.gov.on.ca

POD
ISSN 1198-712X
Également disponible en français
(commande n° 06-012)